U.S. Department of Energy's
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Theory and Computing Program

OFES Budget Planning Meeting

www.ofes.fusion.doe.gov

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Theory Program Goal

- **Achieve a predictive scientific understanding of the behavior of high temperature plasmas**
  - **Provide the critical theoretical effort needed to understand present experiments and suggest new operating regimes or approaches to improve performance**
  - **Acquire improved analytic and computational capabilities in order to make refined comparisons between analytic theory, simulations, and experiments**
  - **Develop an integrated capability to predict the performance of future fusion experiments, especially a burning plasma experiment**

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Research Performers

- The broad range of research themes provides opportunities for both large and small theory groups and individual investigators at national labs, universities, and industry
  - Four laboratory groups, one university group and one industry group with annual funding of $1M or more
  - Three university groups and one industry group with annual funding of $0.5 - $1.0M
  - Unique Institute for Fusion Studies at the University of Texas ($2.3M annual funding)
  - Approximately 30 additional grants ranging from $50K to $500K
- Theory program funding currently supports 95-100 FTEs (including post docs)
- Number of FTEs declining in FY 2004 (due to nearly flat budget)

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Management Approach (I)

- Theory program planning directed by the OFES theory team with support from the Theory Coordinating Committee, a group of leading theorists
  - Focused workshops identify status and opportunities
  - White papers summarize planned work and new research needs and opportunities
- OFES prepares annual solicitations and uses a merit review process to select theory and computing research projects
- SciDAC Program Advisory Committee provides input on SciDAC progress and opportunities
  - A new SciDAC solicitation planned for FY 2004

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Management Approach (II)

- All theory research is peer reviewed
  - New review process initiated three years ago
  - All grants are reviewed every three years on a comparative basis
  - National laboratory theory groups are also reviewed every three years by an on-site panel and by anonymous peer reviewers
- In all cases funding decisions are based on scientific and technical merit and program relevance, with program balance a general consideration

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Results of Grant Reviews

	FY 2001	FY 2002	FY 2003
# Applications Received	23	48	36
# Applications Highly Rated	15	23	18
# Grants Funded	11	10	8 (+3)

- The process is very competitive with only about 1 in 4 applications funded each year
- Only 1-2 new grants funded each year

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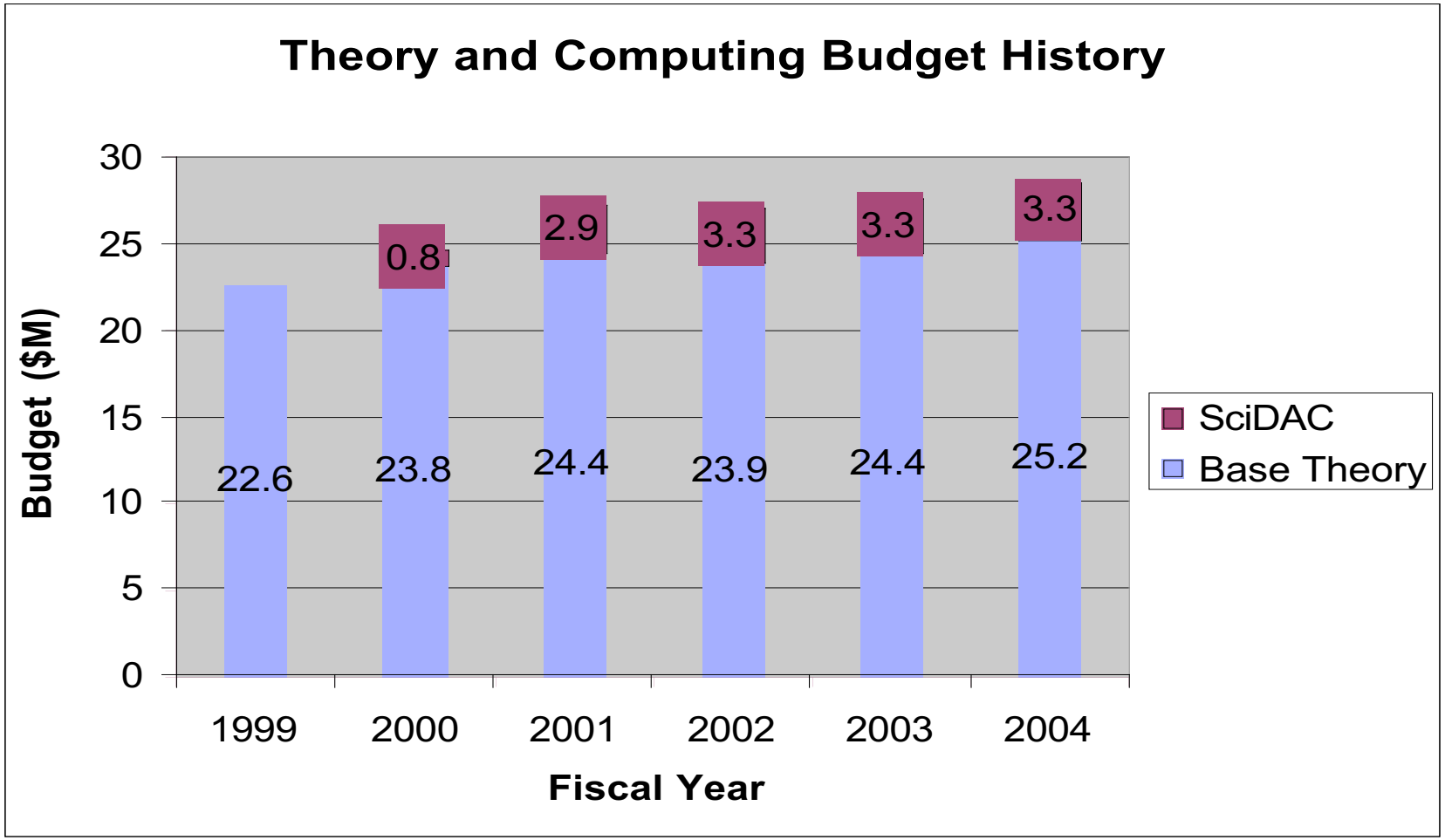
Six-Year Budget History



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Theory and Computing Issues

- Program balance is a challenging issue, especially since we are considering joining the ITER project
  - Advanced tokamak versus innovative confinement concepts
  - Young investigators "graduating" from the junior investigator program versus established scientists
  - Analytic theory versus computation
- What new initiatives are needed to support a burning plasma experiment (e.g. a fusion simulation project)
- Will OFES be required to support capacity (mid-range) computing

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Need for Advanced Simulation

- Analytic theory provides the central organizing concepts of fusion research--the ideas and quantities that frame all thinking about fusion physics
- In fusion and other communities, computational simulation is now an essential element, along with analytic theory and experiment
- SciDAC is making progress, but current simulations involve many simplifications, and key additional physics features must be included to make realistic simulations of fusion power-relevant plasmas
- The Fusion Energy Sciences Advisory Committee has recommended an advanced, integrated simulation program, the Fusion Simulation Project, with initial funding of $20M/year provided by OFES and OASCR
- The goal of the Fusion Simulation Project is to develop a fully integrated simulation capability over 15-year period

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Final Report of ISOFS Subcommittee

The ISOFS Subcommittee recommends that a major initiative be undertaken, referred to here as the Fusion Simulation Project (FSP).

The purpose of the initiative is to make a significant advance within five years toward the ultimate objective of fusion simulation: to predict reliably the behavior of plasma discharges in a toroidal magnetic fusion device on all relevant time and space scales.

The long-term [15 year] goal is in essence the capability for carrying out 'virtual experiments' of a burning magnetically confined plasma, implying predictive capability over many energy-confinement times, faithful representations of the salient physics processes of the plasma, and inclusion of the interactions with the external world (sources, control systems and bounding surfaces).

By its very nature of enabling more comprehensive modeling, the FSP will lead to a wealth of insights not realizable previously, with new understanding in areas as diverse as wall interaction phenomena, the effects of turbulence on long time confinement, and implications of burning plasma self heating in advanced tokamak operating regimes.

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Budget Variations

- Impacts of a 10% decrement
  - An overall decrease in manpower of about 15%
  - We would not use a "peanut butter" approach, but the distribution of reductions would depend on what cuts were made in the remainder of the program
- Incremental funding priorities
  - Fusion simulation project (+$6M increasing to +$12M, with comparable funding provided by OASCR)
  - Stellarator theory (+$2M)
  - Innovative concept (ST, RFP, spheromak,…) theory (+$3M)
  - Edge/pedestal theory (+$2M)

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Backup Slides

Advancing Fusion Science: Fusion Simulation Project

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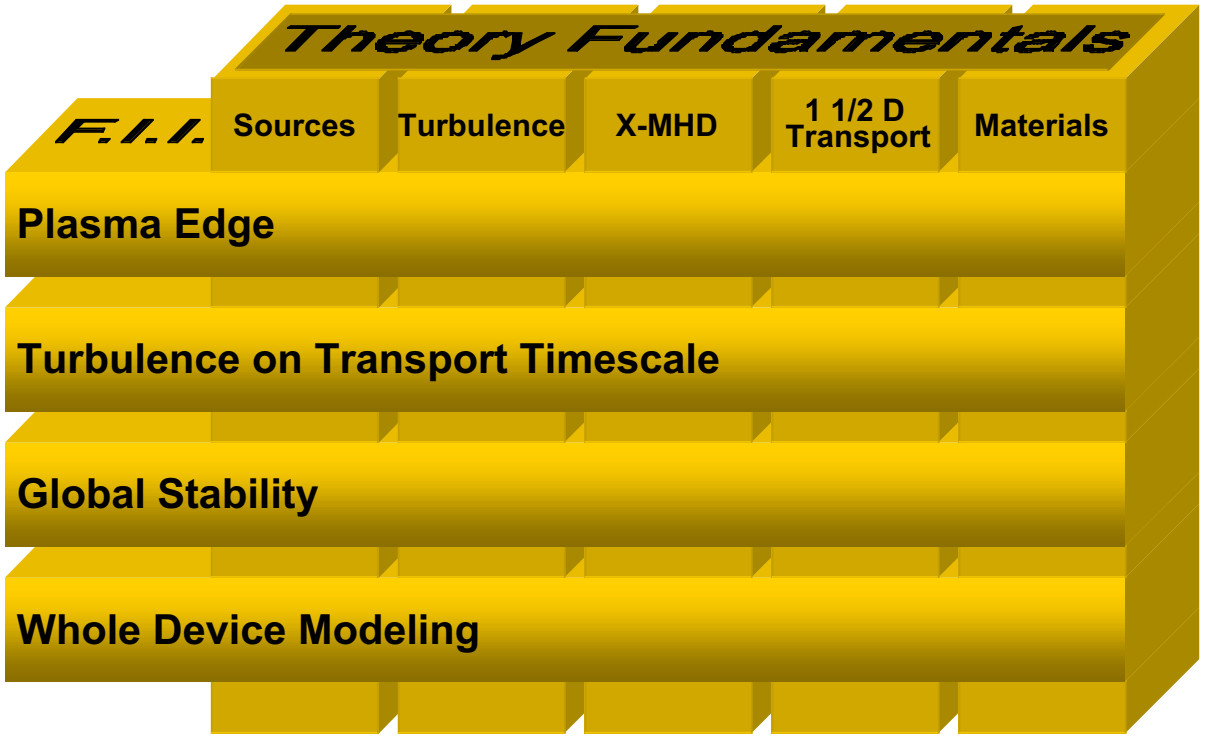
Focused Integration Initiatives

Focused Integration Initiatives are built from Fundamentals of varying complexity with selected algorithms using interoperable software



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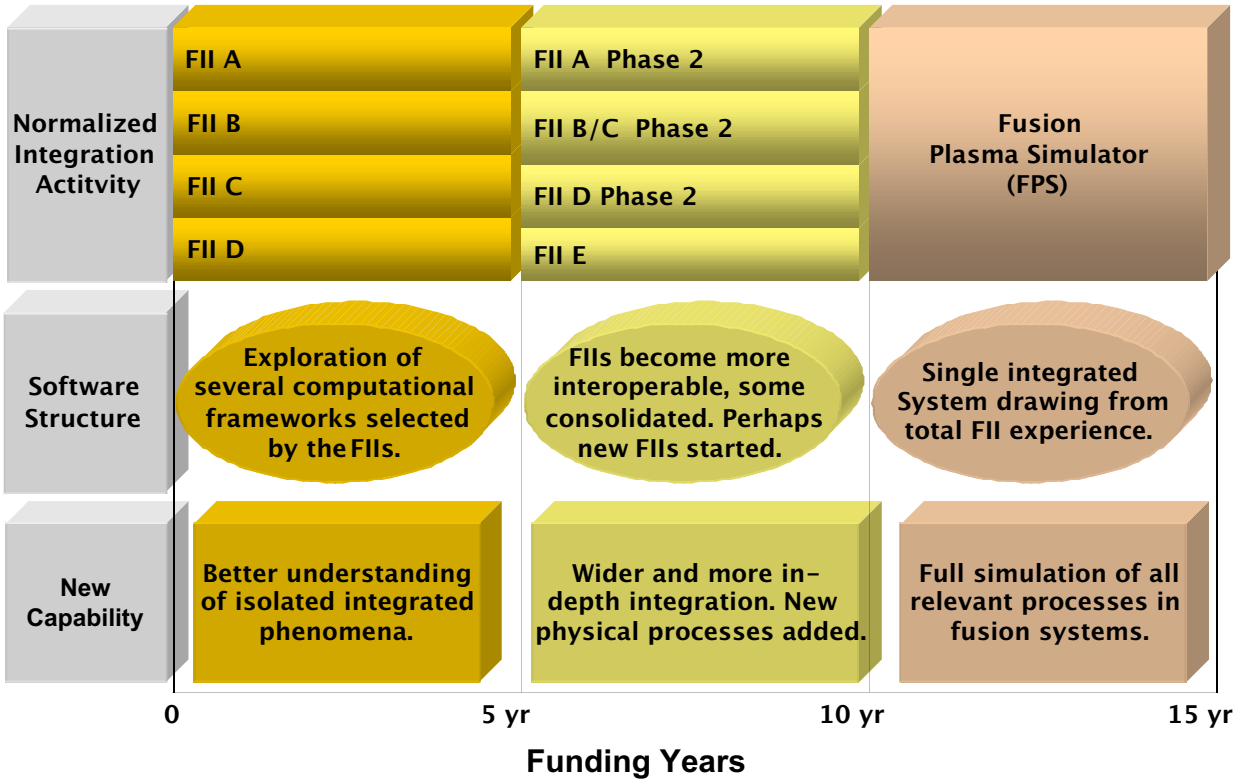
Fusion Simulation Project Roadmap

We expect a 15 year timeline is required to produce the FPS



A fifteen year timeline, with specific milestones at the end of five and ten years. The full extent of the 15-year project is expected to require on the order of $0.4B.

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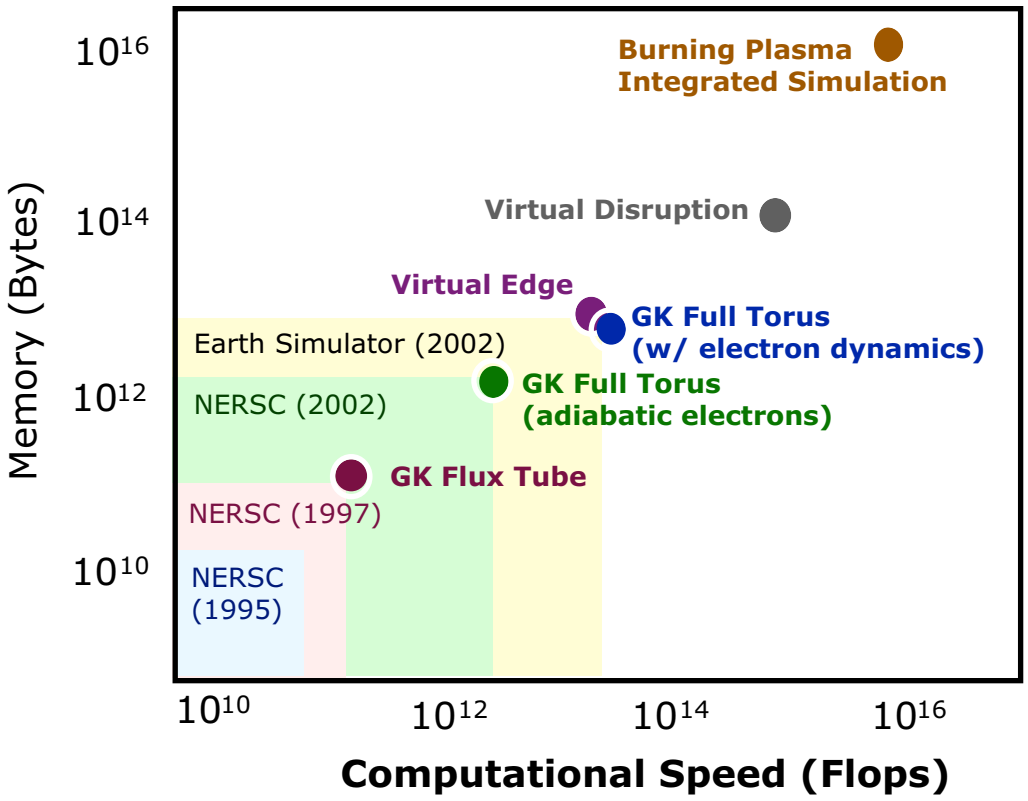
Computation Requirements for Fusion Simulations



The FSP will require significant improvements in computational and network infrastructure, including enhancements to shared and topical resources.